Focus on **Bacterial Source Tracking**

Environmental Assessment and Water Quality Programs

Background

When a water body fails to meet water quality standards for bacteria, the federal Clean Water Act requires the Washington Department of Ecology (Ecology) to initiate a scientific study – a Total Maximum Daily Load (TMDL) analysis. The TMDL analysis of the water body is used to figure out how much bacteria is in the water, the general source areas, and whether the pollution is worse at certain times of year. The main goal of the study is to determine how much the pollution needs to be reduced to meet water quality standards. The state has bacteria standards so citizens can use water (swim, eat shellfish) and not get sick.

How does Ecology identify nonpoint sources of bacteria?

We conduct a year long (minimum) water quality study of possible source areas, such as tributaries, stormwater, and segments of the main stem. Once we've narrowed down the location of the bacterial sources, we work with local people to look more closely at land uses in the area and suspected sources. Since these bacteria come from the feces of warm-blooded animals, the likely causes are limited. We consider such things as:

- Are there septic systems in the area and what condition are they in?
- Could stormwater be carrying pet waste to the water body?
- Do livestock have access to the water?
- Is there a lot of wildlife in the area?
- Could there be a leaking sewer pipe?
- Could there be illegal discharges to the stream?

Ecology works with local interests to identify sources of pollution and develop and implement a water cleanup plan. The plan identifies best management practices or source control corrections that need to be put in place to reduce bacterial pollution. Pollution must be reduced enough to assure that the water body remains healthy.

What happens if wildlife is a major source?

Most bacterial pollution by wildlife is considered a natural contribution that can't be controlled. Human-related sources must still be reduced enough for the water to be safe for uses we enjoy, such as commercial shellfish harvest, swimming and fishing. Bigger wildlife contributions mean the rest of us must contribute less pollution.

Source Tracking Methods

If all the identified source control corrections have been made and there is still a bacteria problem, it may be time to look at additional source identification tools. There are two methods that can be used to conduct bacterial source tracking: pinpointing the location of the source and identifying the types of sources contributing to the problem.

Locating bacterial sources

One of the most economical methods of identifying sources is to conduct intensive upstream-downstream water quality monitoring, including flow measurements, to identify specific stream reaches, land uses, or tributaries that are a problem. This type of monitoring, coupled with good field observation and land use information, can be used to identify sources contributing to the problem.

Dye testing can also be used to determine if on-site sewage treatment systems in an area are functioning properly. Fluorescent dyes, coupled with water quality sampling, are used to test the septic system source.

Determining the types of sources through bacterial source tracking techniques

Most bacterial source tracking techniques are still in the experimental stage and are often quite costly. So it is important to pick the appropriate time to use source identification and then pick the appropriate method. It is also important to remember that these techniques don't tell you how much each source contributes to bacterial contamination, only the different kinds of sources. In addition, it is possible that not all source types will be identified or, with some techniques, that sources will be misidentified.

July 2003 **03-10-059**

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Listed below are some of the available tools, including the more common bacterial source tracking techniques:

1. **Species-specific indicators:** There are a number of bacterial strains that are specific to certain animals. These indicators can be used to determine if bacteria pollution from specific species is present.

2. **Antibiotic resistance analysis:** Humans and animals are exposed to different drugs throughout their lives, so bacteria from animals may not be resistant to drugs that bacteria from humans are resistant to. These resistance patterns can be used to differentiate between human and animal sources.

3. **Chemical indicators:** Chemical indicators are natural by-products of human metabolism or activity. Specific chemicals can be used as tracers to indicate sources or routes of contamination. Examples include testing for the presence of caffeine or optical brighteners (found in laundry detergents) to determine if human sources are present.

4. **DNA typing:** DNA typing is one of the source identification techniques available. Some bacteria uniquely adapt to the gut of the host species. Once they are identified in the host, they can also be identified in the water. The procedure involves creating a "library" of known DNA types, including collecting feces from known species in the watershed. The DNA patterns from bacteria in the water are then compared to DNA patterns in the library.

Does Ecology use this DNA technology?

Ecology has not been using DNA-typing in developing bacteria TMDLs. However, many of our bacteria TMDL projects are a collaborative effort with local governments and tribes. There are a few areas in the state where local governments have done DNA-typing in a watershed in which Ecology has also done a TMDL (examples include Henderson Inlet in Thurston Co. and Clark Creek in Puyallup).

Ecology is still evaluating the accuracy and usefulness of the DNA typing method. There are many cases where a lot of money has been spent on DNA typing (it is very expensive –these studies cost as much as $100,000 or more) when major sources are fairly obvious. When sources are obvious, actions can be taken right away to reduce pollutant loading without extensive testing. Also, methods of bacteria tracking vary, and there has not been an objective evaluation of the different methods and the pros, cons, and accuracy of each.

What are some of the concerns Ecology has with DNA type testing?

- Laboratory cultures of *E. coli* bacteria can consist of hundreds of bacteria "colonies", but the DNA of only a few are actually analyzed. So the method may not represent, or even include, the actual sources in the environment. It cannot with certainty determine the relative amount of bacteria in the water from each species.
- Fieldwork is intensive because numerous water samples are needed and fresh fecal samples from all possible sources must be collected.
- Laboratory analysis is very expensive and time consuming.
- This is an experimental method. The reliability of the method to determine sources is unknown at this time.

Doesn't this method hold some promise for future needs?

There is a strong need to differentiate sources of bacterial contamination. In some cases, DNA typing could lead to faster and more effective cleanups. We recognize the potential of this method and are actively engaged in exploring its usefulness. We are continuing to monitor the state of the science and have been involved in numerous local and national discussions on the topic.

For more information, contact Ann Butler at (360) 407-6480 or email: anbu461@ecy.wa.gov

For an evaluation by Ecology of various source identification methods, please read "Fecal Contamination Source Identification Methods in Surface Water" Ecology report #99-345.

Web site: www.ecy.gov/programs/wq